MEMORANDUM FOR THE RECORD	
SUBJECT: Analysis of Proposal for Color Duplicating System	STAT
1. SA/RED, requested the Advanced Technology	STAT STAT
Branch/RED, to evaluate the proposal of or a color dupli-	_
cating System. This proposal is dated 1 December 1969 and came to RED	
through	STAT
2. The objective of in this proposal, is to produce a color	STAT
copying system with at least 500 lines/mm resolution. The basis for this	
system would be a free-radical material.	
3. At the present stage of development has some materials	STAT
that could be used in a color mode but it appears that they have a very	
long way to go. This will be explained later.	
wants to use the following approach to producing a color	STAT
copying system 1) Examine atternative methods of color image formations	
for feasibility work in depth on one or two of these systems, based on the	
feasibility study and then 3) work to fine tune the material that looks the	
best at this stage.	
5. Attachment A describes the five systems, their color formation	
mechanism and the means of development. The analysis/synthesis filters	
indicates the sizes of the colored imaging/reimaging particles and their	
composition.	

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- 6. The image recording/playback mode in four of the five proposed systems is of the additive type, with its associated disadvantages. A discussion of the additive vs. subtractive systems of color formation follows. May be found in Appendix B.
- 7. As an introduction, all "conventional," true color photographic systems analyze a scene in terms of its red, green and blue components.

 This practice is described in the theory of color vision and is followed in every commercially available color film of the true color variety.
- 8. Because the scene is analyzed in terms of its red, green and blue components, it is necessary to synthesize the scene in a similar fashion.

 That is, the image must modulate the amount of red, green and blue light in amounts similar to their presence in the original scene. The means of color modulation may be either additive or subtractive. In additive systems, Sanitized Copy Approved for Release 2010/03/18: CIA-RDP80T01137A000100010002-7

$m{\varphi}$. In valuating the proposal, I will examine the following areas:	
What are some indempendent views of the materials; how do they	STAT
present their proposed work in this document, and lanalysis from the chemical,	
physical and mechanical standpoint.	
10. As independent inputs for this evaluation I contacted a project	
monitor at Wright Patterson Air Force Base and referred to a materials	
evaluation done at for NPIC. The project monitor	STAT
at WPAFB, has contracts with for a camera speed 🕊 Free Radical	STAT
film. He indicated that as of January 1970, still has significant	STAT
problems with material stability and coating eveness. This substantiates	
the information derived from the SRI evaluating, which indicated similar	
problems with stability and eveness of coating.	
1. The proposal itself suffers from poor organization and a tendency	
to be misleading. For example, references from Mees and	STAT
are used to support case; these references are	STAT
out of context with the original source and often have no relationship to	
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use of them. also confuses work that is done and proven,	STAT
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use of them. also confuses work that is done and proven, with work that is theoretical and yet to be performed. 12. The chemistry of Free Radical Imaging Systems has been established but the modifications needed for the color duping systems, as proposed by have not. The outstanding requirements are the establishment of a panchromatic sensitized direct reversal system with neutral density (grey).	STAT

sensitization of its N-viny/carbozole material that is seriously in question;	
discussion with an inhouse chemist and photo-chemist associated with a photo-	
science contractor indicates a low probability of success of this mode of	
spectral sensitization (see attachment) sel applicacy.	
13. The physical problems with the proposed materials relate	STAT
to the inherent disadvantage of additive color systems limited resolution	
(estimated on the order of $1/4X$ that of 3404) and high base (see attachment)	
density (requiring additional viewing light). The color reproduction cap-	
abilities of additive systems may also be a problem.	
14. In each of the systems, there are severe mechanical problems re-	
lating to production of the original material and its additive screen and	
processing of this material. The color filters used for imaging must be very	
small to maintain resolution and must remain in registration throughout the	
process. In a proposed dye-bleach system indicates it will use a	STAT
tripack with between layer lamination so that the layers may be separated	
for processing and then relaminated in exact register, for viewing; neither	
the mechanics nor the chemistry of this system is simple. In another proposed	
system, a solvent each is needed for reversal processing-then the process	
is no longer dry, which is claimed as an advantage of Free Radical Systems.	
16. Recommendations.	
On the basis of present position in black and white tech-	STAT
nology, with the associated stability and coating problems, it is recommended	
that action on a color system be deferred is now in the process	STAT
of setting up a "commercial" type coater which it is hoped will resolve their	

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stability/coating problems. On the basis of the literature and technology of color photography, I would not advise supporting an additive color system.

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Appendix B

Addrtwevs Sibbractive Color Systems

- 6. The image recording/playback mode in four of the five proposed systems is of the additive type, with its associated disadvantages. A discussion of the additive vs. subtractive systems of color formation follows.
- 7. As an introduction, all "conventional," true color photographic systems analyze a scene in terms of its red, green and blue components. This practice is described in the theory of color vision and is followed in every commercially available color film of the true color variety.
- 8. Because the scene is analyzed in terms of its red, green and blue components, it is necessary to synthesize the scene in a similar fashion. That is the image must modulate the amount of red, green and blue light in amounts similar to their presence in the original scene. The means of color modulation may be either additive or subtractive In additive systems, varying amounts of red, green and blue light the mixed to produce a given The earliest means of color photography used three projectors, one color. with the red separation positive (the black and white transparency of the scene as recorded with a red fitler) and a red filter, the green separation positive and the green filter, and the blue separation positive and a blue filter. The image from each of these projectors was overlapped and the colors in the original scene were reconstructed. The three projector mode of color reconstruction is unwiety and requires precise registration so its analogue was developed. If small particles or beams of red, blue and green light are presented to the eye, it will integrate the three signals seeing them as a single color. This the method of reconstruction used in color televisions and color mosaic photographic systems.

- Q. In the subtractive synthesis method of reconstruction dyes of cyan (absorbs red, transmits blue and green), magenta (absorbs green, transmits red and blue) and yellow (absorbs blue, transmits red and green) are overlapped in varying amounts yielding all colors the dyes can reproduce. Examples of these types of materials are conventional color films, as \$0.242, \$0.121, Ektachrome, etc.
- Each of the systems has its advantages and disadvantages. The additive systems requires simple processing treatment, since it is nothing more than a black and white panchromatic sensitive emulsion overlayed with a grid of red, green and blue filters. Its simplicity of processing must be weighted against its significant disadvantages. The color filter screen used for exposure and viewing limits resolution to the diameter of the individual color filters. This screen must be kept in accurate registration with the sensitive material. Another disadvantage of the additive system is the loss of light through the filters. Red, green, and blue filters each absorb 2/3 of the spectrum and therefore 2/3 of the incident light. If only one color is present, for example, the material will appear to have a base fog density of about .48. From a theoutical standpoint, the additive system may not provide color reproduction of as high as quality as the subtractive system.
- The subtractive system provides good color reproduction and has higher resolution than the additive systems. The disadvantages are that the dyes used in color films may fade more readily than those used in the filters of the additive systems. Also, the additive system requires a complex processing procedure and producing the emulsion itself is difficult

D-R-A-F-T/	STAT
29 January 1970	

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APPENDIX C

RESOLUTION OF ADDITIVE SYSTEMS

As described in Appendix B the additive system of color imaging	
requires a screen of filters for both analyzing the spectral components	
of the scene and for imaging these observed colors. The size of these	
filters is essentially the limiting factor in resolution of these materials,	
as each filter can be considered an imaging center.	
mentions filter sizes on the order of .2 to .3 microns as	STAT
goals of the process. They believe they can get filter sizes of	
l micron with present technology. It is interesting to compare these	
values with the estimated grain size of a high resolution fine grain film	
like 340Y. discusses grain sizes for typical photographic	STAT
materials; on the basis of this. 45microns was chosen as a reasonable	
(if not large) grain size. The area would then be .166micron ² . This	
is about 1/4 the area of each of the imaging centers in the proposed	
work. As a rule of thumb resolution can be expected to change	STAT
in a linear relationship with imaging center diameter. If this is the	
case the resolution of the additive screen system would be at best 1/2	
of the 3404 (considerably less than the 500 1/mm desired).	

APPENDIX D

Discussion of Spectral Sensitization of N-Vinylcarbozole

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In the proposal concerning a color duplicating system,	
describes a mechanism of spectral sensitization that has been questioned	
by two members of the Advanced Technology Branch and a photo-chemist from	
	STAT
As described by "polymerization (of N-Vinylcarbozole) can	STAT
be made to take place at a specific wavelength by energy transfer tech-	
niques if the monomer is adjacent to a color center." These color centers	
are starch grains, dispersed throughout the finder which contains the	
photosensitive N-vinyl carbozole and the activator, carbon tetratromide.	
The mechanism of spectral sensitization via "energy transfer techniques"	
is in question because in silver halide systems it is necessary that the	
sensitizing dye actually be absorbed to the surface of the silver halide	
crystals. When this condition is met there will be energy transfer from	
the dye to the Ag X crystal, resulting in sensitization to these wavelengths	
the dye absorbs. In the they describe a similar technique	STA
but with no contact between the dye (starch grain) and the sensitive media	
(the N-vinylcarbozole).	
For the above reaction to work it would require very significant engrgy	

to polymerize the n-Vinycarbozole; there is a very significant question as to whether this energy could be provided by absorbtion of the proper wavelengths by the dyed starch granules.

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